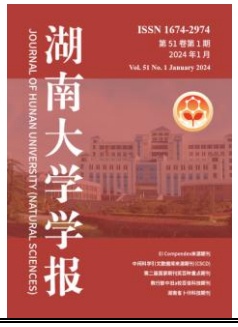

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Maintaining Water Quality in Urban Lakes: Challenges and Strategies

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Abstract: This study aims to develop a comprehensive framework for managing urban lakes under varying environmental conditions and investigates the pivotal role of effective lake management in promoting sustainable development and community well-being, focusing on Malaysia and Australia. The research assesses public perceptions of lake benefits, studies the impact of lakes on quality of life, identifies water quality issues, and proposes an efficient lake management framework. A comprehensive set of examined variables included concerns about lakes, support and financial considerations for lake management improvement, and derived benefits. The 500 distributed questionnaires yielded 320 valid responses employing a survey-based approach. Statistical analyses using SPSS 27 ensured a rigorous evaluation of reliability and validity. Findings regarding lake benefits underscore the significance of positive mood impact, closely followed by physical benefits and nature observation. Exploring lake contribution factors highlighted their crucial role in encouraging patronage of nearby facilities and contributing to community and economic well-being. As for impacts on lake visits and relaxation, this study identified significant reductions linked to water level drops, declining water clarity, green algae cover, and unpleasant odors. Concerns about the changes at the lake were mainly about the financial impact and possible reduction in business for lakeside establishments. A strong endorsement for practical measures such as draining and pumping clean water was evident in support of improving lake water quality. As for potential increases in council rates or water bills, a significant majority resisted any increase, with moderate support for a 5% rise and lower favor for higher increases. The study concludes by emphasizing the critical need to prioritize sustainable lake management practices to prevent water quality degradation. The applicability of these recommendations to diverse environments, especially urban areas benefiting from blue spaces, underscores the importance of the findings. The high reliability and validity of the study's constructs affirm the robustness of the results, providing valuable insights for policymakers and environmental practitioners.

Keywords: lake management, water quality, quality of life, blue space.

維持城市湖泊的水質：挑戰與策略

摘要：本研究旨在製定一個在不同環境條件下管理城市湖泊的綜合框架，並調查有效的湖泊管理在促進永續發展和社區福祉方面的關鍵作用，重點關注馬來西亞和澳洲。該研究評

估了公眾對湖泊效益的看法，研究了湖泊對生活品質的影響，確定了水質問題，並提出了有效的湖泊管理框架。一套全面的檢查變數包括對湖泊的擔憂、對改善湖泊管理的支持和財務考慮以及衍生的效益。採用基於調查的方法，分發了500份問卷，並得到了320份有效答案。使用统计软件27的統計分析確保了對可靠性和有效性的嚴格評估。關於湖泊益處的調查結果強調了正面情緒影響的重要性，其次是身體益處和自然觀察。探索湖泊貢獻因素突顯了它們在鼓勵贊助附近設施以及為社區和經濟福祉做出貢獻方面的關鍵作用。至於對湖泊遊覽和休閒的影響，這項研究發現，水位下降、水體透明度下降、綠藻覆蓋和難聞氣味導致的影響顯著減少。對湖區變化的擔憂主要是對湖濱企業的財務影響和可能的業務減少。對排水和抽取清潔水等實際措施的強烈支持明顯支持改善湖泊水質。至於市政費或水費的潛在增加，絕大多數人反對任何增加，適度支持增加5%，較低的人贊成更高的增加。研究最後強調，迫切需要優先考慮永續湖泊管理實踐，以防止水質惡化。這些建議對不同環境的適用性，特別是受益於藍色空間的城市地區，強調了研究結果的重要性。此研究結構的高可靠性和有效性證實了結果的穩健性，為政策制定者和環境從業者提供了寶貴的見解。

关键词：湖泊管理、水質、生活品質、藍色空間。

1. Introduction

Urban areas worldwide face profound demographic and environmental transformations, with diverse populations seeking healthier and more sustainable living environments. In this context, the concept of blue space has gained prominence as a contemporary issue essential for promoting physical and mental well-being and fostering healthy and sustainable urban living. Blue space encompasses various water features, with lakes and ponds pivotal in urban and environmental planning. They contribute to the overall quality of life by accommodating infrastructure, offering sports, recreation, and tourism, and enhancing cities' environmental and economic well-being [1]. However, the rapid growth of urban populations and urbanization processes exert immense pressure on natural landscapes, resulting in environmental degradation and biodiversity loss [2]. It is imperative to include blue space in urban planning and development to address these challenges and achieve a higher quality of life for urban residents. This integration is crucial for creating resilient, sustainable, and water-sensitive cities, promoting physical and mental health, social cohesion, and community engagement [3].

Notably, case studies from Australia and Malaysia illustrate the importance of urban lakes in enhancing the quality of life among residents. The trend of waterfront revitalization has gained momentum, driven by the recognition of waterfront development's social, economic, and environmental benefits. Urban lakes serve as ecosystems that provide environmental benefits, including air and water quality improvement, biodiversity support, and regulation of urban temperatures. However, urbanization has led to the degradation of many urban lakes, emphasizing the need for their protection and conservation.

Urban lakes offer various functions such as recreation, tourism, biodiversity conservation, and water supply. Their multiple uses require sustainable management practices to balance diverse needs minimizing adverse environmental impacts. Given the global trend of rapid urbanization, it is imperative to conduct intensive research to understand the distribution and characteristics of urban lakes and guide effective city development. Preserving these ecosystems using sustainable management practices benefits the environment and positively impacts local communities' social and economic well-being.

Therefore, this study aims to develop a comprehensive framework for managing urban lakes under varying environmental conditions in Australia and Malaysia. The text underscores the multidimensional importance of urban lakes, their contributions to urban life, and the urgency of implementing sustainable management practices for their protection and conservation.

2. Methodology

2.1. Case Study

For this investigation, two areas were identified as the case study area: Taman Tasik Universiti Teknologi Petronas (UTP), Malaysia, and Shearwater Lakes, Adelaide, Australia. The chosen areas were determined based on their naturally urbanized landscape showcasing stunning urban lakes and picturesque

natural surroundings. These lakes serve as recreational hubs, offering activities such as jogging, water sports, and picnicking to the public, enhancing physical activity and relaxation. Despite their geographical distance, these case studies reveal shared challenges. Rapid urbanization and population growth in both countries have increased the demand for water resources, leading to significant water pollution issues in these urban lakes. Pollution, often stemming from rapid industrialization and urban development, has caused problems such as algae blooms and eutrophication in both Australian and Malaysian urban lakes. In addition, both countries face the common challenge of managing the impact of climatic changes on their urban lakes. These lakes attract diverse visitors, including residents, institution members, and tourists drawn to the natural beauty and recreational opportunities, resulting in thousands of annual visitors.

2.2. Survey

For this study, the survey strategy as a quantitative research method is the most used technique and is also the most suitable for this investigation. It consists of cross-sectional and longitudinal studies that collect significant data using questionnaire surveys.

The questionnaires were used to collect the views of the public institution experts. The critical measurement issues covered through the questionnaires were institutional and legal frameworks, resource aspects, practices of stakeholder integration, and methods of public awareness programs. A set of questionnaires was developed containing demographics, including gender, birth year, employment status, education, and household status. The questionnaire was divided into two sections (Part one and Part two), as shown below.

- Part one included information about space and place. The question explored participants' use of the lake in their area/residential area and the benefits derived from the lake. The respondent was requested to mark or select the appropriate box to indicate the extent to which coordination factors were based on their experience of the events.
- Part two included questions about the changes in lake water quality and the scenario's impact, their concern about the changes, and their willingness to pay for environmental services. The respondent was requested to mark or select the appropriate box to indicate the extent to which coordination factors were based on their experience of the events.

There were 39 questions altogether in two languages, English and Malay. The questionnaire was administered to 500 participants who stayed within the district of the case study area. The number of sampling units was determined according to the population in each area to ensure that the samples were representative. Data were collected between June 2020 and October 2020, March 2021 and July 2021, and June 2023 and October 2023 using an online questionnaire at the lake and through a home-to-home postal box. Of the 500 questionnaires collected, 320 were valid for the study, and the remaining 180 were eliminated from the study because of missing answers to one or more questions or inconsistent replies.

2.3. Data Analysis and Presentation

The data collected through questionnaires in the study were analyzed for descriptive statistics, Cronbach's alpha and validity tests. The data were collected from the respondents using SPSS 22.0 version software for measuring the reliability of the survey.

3. Results and Discussion

3.1. Demographic Analysis

Most respondents were female (64.7%) and highly educated (78.1%) with a bachelor's degree or higher, as shown in Table 1. There are 16.83 million males and 15.94 million females in Malaysia. The percentage of the female population is 48.64% compared with 51.36% of the male population [4]. According to census data from the Australian Bureau of Statistics, 2015, the study sample demography does not necessarily reflect the South Australian population, which has a lower proportion of females at 50.7% [5]. The researcher found that there were more female respondents than male respondents. In this situation, female respondents were more likely to participate in recreational activities to have pleasure and satisfaction.

Table 1 Demographic analysis (Developed by the authors)

Variable	Option	Percentage
Gender	Female	64.7
	Male	35.3
Education	Postgraduate degree	39.8
	Bachelor's degree	38.3
	Diploma degree	6.8
	Secondary school	6.1
	Primary school	4.5
	STPW foundation	3
	Vocational/technical	1.5

Moreover, the Commonwealth of Australia in 2006 argued that more women now engage in physical activity [6]. However, the percentages show that there is not much difference between males and females. This is because urban blue spaces benefit their visitors regardless of gender. Respondents from Australia were also included in the study to make the research more generic and compare findings with those from Malaysia. These respondents comprised individual residents working in both the private and public sectors from different backgrounds and various specializations who were asked to provide essential credible data from within their respective opinions.

3.2. Descriptive Analysis

The first part is to acquire more information about

accessing the significant benefits that the public derives from lakes and the role and impact of the lakes on quality of life. The data analysis's main goal is to quantitatively identify the relevance of the variables in Malaysia and Australia. Many previous studies have emphasized the need for normal distribution before determining a proper statistical analysis.

3.2.1. Benefit Factors

Table 2 presents the results in descending order of mean value, and the obtained responses indicate that a visit to the lake would have a positive effect (B14) as the most significant benefit derived with a mean value of 4.09 and SD of 0.830. The second and third significant benefit factors were physical benefits (B12) and observing nature and wildlife (B11), with mean values of 4.08 and 3.91, respectively. This finding agrees with [7]. The least significant benefit factors are around people who are like me (B09); visiting the lake would have a very negative effect on my stress level (B13) and improve fitness (B01) with mean values of 3.59, 3.57, and 3.45, respectively. From the kurtosis and skewness obtained, the result indicates that the data are normally distributed as its ranges of ±2 that comply with the requirement stated by [8].

Table 2 Variables of benefit factors (Developed by the authors)

I.D.	Variables
B01	Improve fitness
B02	Enjoy tranquillity
B03	Rest or relax
B04	Spend time outdoors
B05	Escape stress or pressure
B06	Enjoy the sounds and smells of nature
B07	Spend time with friends
B08	Connect with the family
B09	Be around people who like me
B10	Think or reflect
B11	Observing nature and wildlife
B12	Physical benefits
B13	Visiting the lake can very negatively affect my stress level
B14	A visit to the lake can positively affect my mood

Table 3 Benefit factor analysis results (Developed by the authors)

I.D.	Mean	SD	Skewness		Kurtosis		Rank
			Statistic	Std Err	Statistic	Std Err	
B14	4.09	0.830	-0.788	0.205	0.651	0.407	1
B12	4.08	0.937	-1.062	0.205	1.139	0.407	2
B11	3.91	1.096	-0.750	0.206	-0.234	0.408	3
B03	3.82	1.146	-0.516	0.205	-0.644	0.407	4
B05	3.76	1.097	-0.647	0.205	-0.156	0.407	5
B02	3.74	0.979	-0.566	0.205	0.152	0.407	6
B06	3.69	1.099	-0.585	0.205	-0.147	0.407	7
B10	3.67	1.115	-0.614	0.205	-0.128	0.407	8
B04	3.65	1.059	-0.402	0.205	-0.479	0.407	9
B07	3.65	1.099	-0.554	0.205	-0.086	0.407	10
B08	3.64	1.177	-0.573	0.205	-0.334	0.407	11
B09	3.59	1.137	-0.486	0.205	-0.404	0.407	12
B13	3.57	1.270	-0.622	0.205	-0.715	0.407	13
B01	3.45	1.219	-0.365	0.205	-0.587	0.407	14

3.2.2. Lake Contribution Factors

Table 4 shows the results of the lake's contribution to community development as proposed by the respondent. The lake encourages you to patronize nearby facilities (LC02) with a mean value of 3.99 and standard deviation (SD) of 0.921, which is ranked first among the variables. The least significant lake contribution factor was other features or facilities that would encourage you to visit the lake more frequently (LC04), with mean and SD values of 3.24 and 1.493, respectively. The skewness and kurtosis obtained also show that the data are normally distributed.

Table 4 Variables of lake's contribution factors (Developed by the authors)

I.D.	Variables
LC01	Personal value most about the lake
LC02	Lake encourages you to patronize nearby facilities
LC03	Lake contributes to property value
LC04	Any features or facilities that would encourage you to visit the lake more frequently

Table 5 Lake's contribution factor analysis results (Developed by the authors)

I.D.	Mean	SD	Skewness		Kurtosis		Rank
			Statistic	Std Err	Statistic	Std Err	
LC02	3.99	0.921	-0.812	0.205	0.489	0.407	1
LC01	3.99	0.952	-0.936	0.205	0.771	0.407	2
LC03	3.70	1.199	-0.903	0.206	0.208	0.410	3
LC04	3.24	1.493	-0.468	0.206	-1.215	0.408	4

3.2.3. Personal Relationship to Lake Factors

The personal attitude s of the respondents are discussed in Table 6. Feeling happiest when I am at the lake (PR05) and how concerned are you about the changes (PR09) are the most significant factors with mean values of 3.89 and 3.81, respectively, which are ranked first and second. The third personal relation factor is that the lake is the best place to do the activities that I enjoy doing (PR07), with a mean value of 3.64 and a SD of 1.04. The findings agree with those of the study conducted by [9].

Table 6 Lake's contribution factor analysis results (Developed by the authors)

I.D.	Variables
PR01	I am attached to the lake
PR02	The lake means a lot to me
PR03	The lake is a special place for my family
PR04	Many important family memories are tied to the lake
PR05	I feel happiest when I am at the lake
PR06	No other place can compare to the lake
PR07	The lake is the best place to do the activities that I enjoy doing
PR08	I get more satisfaction out of visiting the lake than any other park
PR09	How concerned are you about the undesirable changes to the lake?

Table 7 Personal attitude to lake analysis results (Developed by the authors)

I.D.	Mean	SD	Skewness		Kurtosis		Rank
			Statistic	Std Err	Statistic	Std Err	
PR05	3.89	0.968	-1.121	0.205	1.544	0.407	1
PR09	3.81	1.127	-0.981	0.206	0.431	0.408	2
PR07	3.64	1.040	-0.777	0.205	0.424	0.407	3
PR02	3.58	0.955	-0.646	0.206	0.384	0.408	4
PR08	3.56	1.088	-0.676	0.205	0.010	0.407	5

Continuation of Table 7							
PR01	3.54	1.048	-0.666	0.205	-0.030	0.407	6
PR03	3.51	1.096	-0.636	0.205	-0.145	0.407	7
PR06	3.30	1.104	-0.457	0.205	-0.464	0.407	8
PR04	3.19	1.125	-0.173	0.205	-0.757	0.407	9

The least significant personal relation factors of the respondent with lakes are that the lake is a special place for my family (PR03), no other place can compare to the lake (PR06), and many important family memories are tied to the lake (PR04), with mean values of 3.51, 3.30, and 3.19, respectively. In addition, the kurtosis and skewness values obtained also indicate that the data is normally distributed in the range of ±2.

3.2.4. Impacts of Events on the Frequency of Visits to Lake

Respondents were asked to indicate the impact that event would have on the frequency with which they visited the lake, and the results obtained show that visits to the lake will reduce significantly on all the variables, as can be seen from the mean values obtained as shown in Table 8. The water level drops significantly, the lake becomes quite shallow (VS02), and water clarity declines. The water becomes dark and murky (VS03), which is more significant, with mean values of 2.38 and 2.36, respectively. The water in the lake emits a very unpleasant odor (VS04) and has the lowest mean value of 2.24, which signifies that it is the most worrisome, as proposed by the respondent. This clearly indicates that all variables will affect the rate of visits to the lake, which agrees with [10].

Table 8 Variables of lake's contribution factors (Developed by the authors)

I.D.	Variables
VS01	Green algae cover the surface of the water in the lake
VS02	The water level drops significantly, and the lake becomes quite shallow
VS03	Water clarity declines and the water becomes dark and murky
VS04	The water in the lake emits an unpleasant odor

Table 9 Lake visiting impact analysis results (Developed by the authors)

I.D.	Mean	SD	Skewness		Kurtosis		Rank
			Statistic	Std Err	Statistic	Std Err	
VS02	2.38	1.096	0.531	0.205	-0.485	0.407	1
VS03	2.36	1.176	0.619	0.205	-0.488	0.407	2
VS01	2.26	1.148	0.854	0.205	0.048	0.407	3
VS04	2.24	1.243	0.710	0.206	-0.603	0.408	4

3.2.5. Impacts of Events on Relaxation at Lake

The results obtained also indicate that relaxing at the lake can be significantly affected due to reasons, as shown in Table 10, with all factors having a mean value slightly above 2. The water level drops significantly, the lake becomes quite shallow (RL02), and green algae covering the surface of the water in the lake (RL01) is more significant. Furthermore, the water in the lake emits a very unpleasant odor (RL04) with a mean value of 2.01, which is the biggest issue that hinders people from relaxing at the lake due to back odor.

Table 9 Variables of lake relaxation impact factors (Developed by the authors)

I.D.	Variables
RL01	Green algae cover the surface of the water in the lake
RL02	The water level drops significantly, and the lake becomes quite shallow
RL03	Water clarity declines and the water becomes dark and murky
RL04	The water in the lake emits an unpleasant odor

Table 10 Variables of lake relaxation impact factors (Developed by the authors)

I.D.	Mean	SD	Skewness		Kurtosis		Rank
			Statistic	Std Err	Statistic	Std Err	
RL02	2.27	1.105	0.774	0.205	-0.117	0.407	1
RL01	2.16	1.237	0.970	0.205	-0.012	0.407	2
RL03	2.14	1.209	0.961	0.205	-0.027	0.407	3
RL04	2.01	1.112	0.958	0.205	0.023	0.407	4

The results collectively indicate that various environmental factors significantly influence the community's ability to relax at the lake. Water-related issues such as decreased water levels, algae presence, poor water clarity, and unpleasant odors are key contributors to a less-than-ideal lakeside experience. Addressing these concerns is crucial not only for enhancing the esthetic appeal of the lake but also for ensuring a positive and rejuvenating environment for the community. Community initiatives or management strategies aimed at mitigating these factors could contribute to a more enjoyable and restful lakeside atmosphere.

3.2.6. Concerns on Changes Occurring in Lake

Results indicate the respondent's concern regarding the factors shown in Table 12. Findings show that the respondents are more concerned with council funding redirected to remedy the undesirable change (HC05) and a reduction in business for lakeside cafes and stores (HC06), with mean values of 3.36 and 3.35 ranked first and second, respectively. The least significant among the variables were a decline in the esthetic beauty of the lake (HC02) and negative impacts of the change on local property values (HC01), with mean values of 2.97 and 2.89, respectively. Skewness and kurtosis values also show the data to be normally distributed being in the range of ±2. Most respondents indicated that the quality of water in the lake they visited was good.

Table 11 Variables of lake contribution factors (Developed by the authors)

I.D.	Variables
HC01	Negative impacts of change on local property values
HC02	Decline in the esthetic beauty of the lake
HC03	Negative effects on local birds and wildlife
HC04	Increased health risks associated with recreating in the lake
HC05	Council funding being redirected to remedy undesirable changes

Continuation of Table 11	
HC06	Reduction in business for lakeside cafes and stores

Table 12 Lake's change impact analysis results (Developed by the authors)

I.D.	Mean	SD	Skewness		Kurtosis		Rank
			Statistic	Std Err	Statistic	Std Err	
HC05	3.36	1.186	-0.520	0.206	-0.537	0.408	1
HC06	3.35	1.137	-0.545	0.205	-0.372	0.407	2
HC04	3.29	1.277	-0.447	0.205	-0.839	0.407	3
HC03	3.21	1.178	-0.384	0.205	-0.664	0.407	4
HC02	2.97	1.175	-0.052	0.205	-0.804	0.407	5
HC01	2.89	1.262	0.030	0.205	-0.948	0.407	6

The results highlight that the community is particularly sensitive to economic considerations, emphasizing the need for sustainable management practices that consider the financial aspects of lake changes. Health and ecological concerns are also significant, indicating that a holistic approach to lake management is essential for addressing the diverse concerns of the community. The normal distribution of skewness and kurtosis values within the range of ±2 indicates that the data are well distributed, enhancing the reliability of the findings.

3.2.7. Support to Improve Lake Water Quality

Table 14 indicates respondent support on measures to be followed to improve the water quality of lakes, with draining the lake to clean out accumulated waste ($S0_2$) being the topmost supported item by the respondent, with mean and SD values of 3.94 and 0.995, respectively. This is followed by pumping clean water to artificially raise the water level (S06) and planting more shoreline vegetation such as reeds (S01) with mean values of 3.94 and 3.89, which rank second and third,, respectively.

The least supported activity from the results obtained are adding chemicals such as algae control agents to clean the water (S08), introducing a virus to kill the carp (exotic fish) in the lake (S07), and leaving the lake as it is and not changing anything (S09), with mean values of 3.34, 3.29, and 3.16, respectively. This agrees with [11]. In addition, the results indicate that most of the respondents are satisfied with the council's current management of its lake.

The community shows a preference for proactive and transformative measures, such as draining the lake and introducing clean water, over passive approaches, such as leaving the lake unchanged. Natural and ecologically friendly methods, such as planting shoreline vegetation, garner considerable support, aligning with sustainable and environmentally conscious practices. Moderate support for chemical interventions and the introduction of viruses indicates a nuanced perspective, emphasizing the importance of considering potential risks and benefits.

Table 13 Lake's contribution factors analysis results (Developed by the authors)

I.D.	Variables
S01	Planting more shoreline vegetation such as reeds
S02	Draining the lake to remove accumulated waste
S03	Banning public use of water bodies for sport and fishing
S04	Install floating islands of aquatic plants
S05	Filling in the lake and converting it to a public park/green space
S06	Pumping clean water to artificially raise the water level
S07	Introducing a virus to kill carp (exotic fish) in the lake
S08	Adding chemicals such as algae control agents to clean the water
S09	Leaving the lake as it is and not changing anything

Table 14 Lake's change impact analysis results (Developed by the authors)

I.D.	Mean	SD	Skewness		Kurtosis		Rank
			Statistic	Std Err	Statistic	Std Err	
S02	3.94	0.995	-0.774	0.205	-0.001	0.407	1
S06	3.94	0.915	-0.843	0.205	0.611	0.407	2
S01	3.89	0.968	-1.072	0.205	1.259	0.407	3
S04	3.81	1.015	-1.126	0.205	1.171	0.407	4
S05	3.67	1.214	-0.861	0.205	-0.078	0.407	5
S03	3.65	1.163	-0.649	0.205	-0.297	0.407	6
S08	3.34	1.186	-0.511	0.205	-0.590	0.407	7
S07	3.29	1.248	-0.419	0.206	-0.843	0.408	8
S09	3.16	1.380	-0.320	0.205	-1.147	0.407	9

3.2.8. Increase Your Council Rates or Water Bills to Rectify Each Change

This category represents the majority opinion among respondents, with 42.1% expressing a preference for maintaining current billing levels. Community members in this segment are hesitant to bear any additional financial burden of lake rectification projects. A significant portion of respondents, constituting 34.3%, were willing to accept a modest 5% increase in bills to support environmental changes in lakes. This group demonstrated a moderate level of financial commitment toward lake improvement initiatives, as shown in Fig. 1. A smaller but notable segment, accounting for 14.3% of respondents, is open to a more substantial 10% increase in bills. This indicates a willingness among a subset of the community to contribute more significantly to address environmental challenges in lakes. The least represented category comprises respondents (8.6%) who are willing to support lake improvement through a 20% increase in bills. This group reflects a minority with a higher threshold for financial commitment, potentially emphasizing the perceived importance of lake conservation, as shown in Fig. 1.

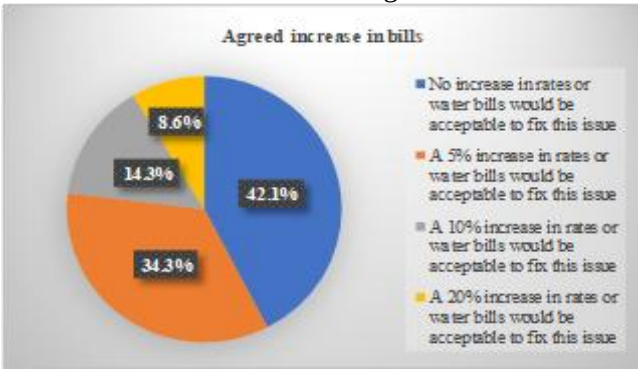

Fig. 1 Agreed increase in bills (Developed by the authors)

The contingent valuation method is a popular technique used to assess the economic value of public goods or services, such as lake improvement projects. This method involves surveying a representative sample of the population to estimate their willingness to pay for a particular project, which can then be used to calculate the total economic value of the project [12]. In a recent study on urban lakes, researchers used the contingent valuation method to assess residents' willingness to pay for lake conservation efforts aimed at maintaining sustainable urban lake management.

3.2.9. Personal Opinion about Lake

The results obtained indicate that I feel very connected to all living things and the earth (M06), and my relationship to nature is an important part of who I am (M05), with mean values of 3.97 and 3.91, respectively, being the most significant among other personal opinion variables, as proposed by the respondent. The least important factors are that I always think about how my actions affect the environment (M02) and that my ideal vacation spot would be a remote, wilderness area (M01) with mean values of 3.82 and 3.48, respectively, as shown in Table 16. Skewness and kurtosis values are within the range of ±2, indicating that data are normally distributed.

Table 15 Variables of lake contribution factors (Developed by the authors)

I.D.	Variables
M01	My ideal vacation spot would be a remote, wild area
M02	I always think about how my actions affect the environment
M03	My connection to nature and the environment is a part of my spirituality
M04	I take notice of wildlife wherever I am
M05	My relationship with nature is an important part of me
M06	I feel very connected to all living things and the Earth

Table 16 Lake's change impact analysis results (Developed by the authors)

I.D.	Mean	SD	Skewness		Kurtosis		Rank
			Statistic	Std Err	Statistic	Std Err	
M06	3.97	0.981	-0.822	0.205	0.344	0.407	1
M05	3.91	0.988	-0.855	0.205	0.554	0.407	2
M03	3.89	0.914	-0.917	0.205	0.988	0.407	3
M04	3.84	0.895	-0.465	0.205	0.113	0.407	4
M02	3.82	0.976	-0.950	0.205	0.908	0.407	5
M01	3.48	1.141	-0.728	0.205	-0.084	0.407	6

3.3. Reliability and Validity

The reliability test is crucial in ensuring that the data collected from the questionnaire is of high quality and can yield consistent and reliable findings. A reliability test was conducted to evaluate the quality of the data collected from our questionnaire. During the reliability test, we applied internal consistency analysis to measure whether the items in our questionnaire were stable and produced consistent results [13]. This reliability test ensured that the questionnaire instrument used in our study provided accurate and reliable data.

Table 17 Variables of lake contribution factors (Developed by the authors)

Cronbach's alpha coefficient	Level of reliability
0.80–0.95	Very good reliability
0.70–0.80	Good reliability
0.60–0.70	Fair reliability
$\alpha < 0.60$	Poor reliability

Table 18 Variable of lake contribution factors (Developed by the authors)

Construct	No. of items	Cronbach's alpha value
Access the significant benefits that the public derives from lakes and the role and impact of lakes on quality of life	27	0.875
Rank the issues of lake management that lead to adverse effect on water quality	31	0.798

The results show that the items have a high level of internal consistency. This shows that respondents who seek to select high ratings for one component generally do so for the others. Moreover, the reliability statistics of the questionnaire were measured using Cronbach's alpha test, as this tool is recommended for measuring internal consistency on the same construct. Cronbach's alpha coefficient was also used as an index of reliability to test the internal consistency or reliability of the questionnaire. Furthermore, other sources used in this study also showed that the internal consistency of our questionnaire was acceptable and reliable. This test ensured that our questionnaire produced consistent and reliable data, ultimately increasing the validity of the research findings.

This study on urban lake water quality aligns with [14-16] by emphasizing the significance of public perceptions. Kallis et al. [17] reported higher support for cost increases, while [18] reported that rapid urbanization negatively affects water quality. Our study supports this finding, indicating a significant reduction in lake visits and relaxation linked to urban-related issues such as water level drops and declining water clarity.

Overall, this research adds nuanced insights to the urban lake water quality discourse while building on established frameworks in the field.

4. Conclusion

Freshwater resources in many urban environments are highly vulnerable to human pressures, climate variability, and change. Sustainable urban lake management practices can positively impact water quality in these environments. These practices can include reducing pollution inputs, implementing storm water management strategies, and promoting environmental restoration. Sustainable urban lake management practices can significantly improve water quality in urban environments. Sustainable urban lake management can also help address other challenges related to water security and the conservation of land

and water resources. In conclusion, sustainable urban lake management has a significant positive effect on water quality that benefits the ecosystem health, providing better habitat for aquatic species, and positively impacts human health and well-being.

5. Limitations and Future Studies

This study relies on respondents who know the research topic and answer the relevant questions. The research survey was based on data collected from a sample using a composite sampling approach and was preceded by a pilot study. Because few respondents had experience or expertise in urban lake management, not every respondent had knowledge that could contribute to the research issue. However, time, administrative, and financial constraints took pace. Nevertheless, the study's utility remains because it does not remove limitations but makes future research possible.

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